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Angle-resolved evolution of the composition of Cr-Al-C thin films deposited by sputtering of a compound target

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The composition of multi-element thin films deposited by magnetron sputtering of a single target may significantly differ from the target composition. Differences in the sputter emission characteristics (angle and energy distributions) and transport of the sputtered species through the gas phase for different elements were shown to be responsible for this phenomenon [Neidhardt et al., J. Appl. Phys. 104, 063304 (2008)]. The evolution of the composition of Cr-Al-C thin films deposited by magnetron sputtering of a compound target has been investigated as a function of the deposition pressure from 0.2 to 3.0 Pa, corresponding to the pressure-distance product range from 1.4 to 21.0 Pa.cm. Additionally, the angle between target normal and substrate normal was varied from 0° (on axis deposition) to 67.5°. Good agreement between the experimental data and an extended Monte-Carlo model based on TRIDYN and TRIM simulations has been observed even for a target containing three chemical elements. This suggests a rather general applicability of the here developed model. Trends in composition of compound thin films deposited by magnetron sputtering from a single compound and/or powder metallurgical composite targets can be predicted. These findings are of considerable relevance for high throughput production in industry.

Keywords
compound target
film composition
pressure-distance product
TRIDYN simulations
TRIM simulations